EXECUTIVE SUMMARY

This research involves two studies: one to determine the local geoid to obtain mean sea level (m.s.l.) elevations from a global positioning system (GPS) to an accuracy of ±2 cm, and the other to determine the location of roadside features such as mile posts, stop signs, etc., for safety studies, geographic information systems (GIS), and maintenance applications, from video imageries collected by a van traveling at traffic speed.

In order to determine local geoid for Story County, nine benchmarks with known m.s.l. elevations distributed in both *x*, *y* directions covering the area were selected. Four phases of observations at six-month intervals were done. The first phase showed that the maximum variation of the local geoid is about 9 cm, suggesting the need for a local geoid to determine m.s.l. elevations from GPS. The first phase also showed that a local geoid contour from two base points can be used to determine m.s.l. elevations from GPS with accuracy better than ±2 cm.

Phases II, III, and IV were conducted to study the variation of the local geoid with time and find a method to forecast it. Phase II observations showed that there was a positive change in the local geoid over the six-month period. Phase III showed that the variation fluctuated with time and the mean of all three had standard errors of less than ±2 cm. This phase also showed that both Kalman filtering and moving average forecasted values agreed within ±2 cm. Phase III indicated the need for a fixed-height antenna for all the stations, and it was noted that the variations in local geoid may be due to motion of the axis of rotation of the earth.

Phase IV showed that the observed local geoid undulation agreed within ±2 cm with the forecasted values. The forecasted values by moving average were slightly better than those produced through Kalman filtering. The moving average of the last three phases local geoid undulation can be used to correct GPS observations for the next two years. Also, the difference between session A (morning four hours) and session B (afternoon four hours) agreed within ±2 cm, indicating the need for a fixed-height antenna and suggesting that two sessions of observation can be used to detect blunders.

The video logging van equipped with a high-resolution video camera, P-code phase GPS system, and inertial navigation system owned by the Iowa Department of Transportation (Iowa DOT) was calibrated using the special three-dimensional calibration range established at Iowa State University. Sequential imageries can then be used to determine locations on a local coordinate system without any control by constraining the interior and exterior orientation elements from calibration. The local coordinates can then be transformed to state plane coordinates using the camera locations determined by GPS. The van was used to capture imageries at three test sites: Grand Avenue, an urban site, at 25 mph; EDM baseline, a rural site, at 40 mph; and US 30 in Nevada, a freeway, at 55 mph. Evaluation of the data using both Calib, a research software, and SoftPlotter, a production software, showed that the roadside feature location can be determined with relative accuracy better than 10 cm and absolute accuracy of ±2 m, depending on the global positioning system. The coordinates determined have to be corrected for any systematic error caused by the GPS code phase system by having a control point every 15 miles. The method developed was used to determine the state plane coordinates of mileposts and anchor points

located along a 14-mile portion of US 30 from Ames to Nevada, Iowa. This information can be used in GIS and maintenance applications, as well as in safety studies.

It is recommended that the results of this research be presented at local, national, and international conferences. It is recommended that the variation of local geoid over a long period of time, about 4–18 years, be studied so as to determine the validity of the moving average. Finally, it is recommended that the Iowa DOT update the video logging van with a kinematic carrier phase GPS and conduct research with automatic data capture and creating virtual roads.